Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

THE EFFECT OF ALGAE ON BICARBONATES IN SHALLOW RESERVOIRS

By S. T. Powell[1]

The microscopical examinations of public water supplies have become universal, and in many places constitute routine laboratory tests, but these determinations are made principally for the purpose of the treatment of the supplies for the removal of algae and similar micro-organisms causing tastes and odors in the water. Water works superintendents and chemists in charge of such works have given but little study to the biochemical reactions of such plant life when present in reservoirs, and with the exception of various limological investigations that have been made, little data of this character are available. It is a well known fact, however, that these organisms do have a great effect upon the physical, chemical and biological quality of stored water.

In a recent investigation undertaken to determine the effect of dissolved gases in stored water upon ozonization of the supply of the Baltimore County Water and Electric Company, it was clearly demonstrated that certain forms of algae can within a comparatively short time entirely remove the free carbon dioxide from the water, as well as use up a considerable amount of the half bound carbon dioxide, thereby reducing the bicarbonate of calcium and magnesium to normal carbonates of these salts; at the same time causing the dissolved oxygen content of the supply to rise to a point of excessive supersaturation. Such conditions have been noted by many investigators, but these phenomena are not usually to be found in shallow reservoirs where the storage period of the water is relatively short and where the supply of free CO_2 in the raw water is considerable, due to high organic contents.

The two reservoirs used for storage purposes on the Herring Run system of this company are operated continuously, and have a combined storage capacity sufficient for twenty-one days' supply.

---

[1] Chemist and Bacteriologist of the Baltimore County Water and Electric Company.

The lower reservoir, which was put in use about twenty years ago, is an excavated earthen basin around which a bank was placed. When first put into service the top soil was not stripped but later the greater portion of it was removed to a depth of 12 inches. About four years ago on the bank of the lower side of this reservoir was placed a concrete slab so as to prevent high turbidities in the water on account of washing of the slopes during storms. Due to the organic nature of the contents of the water, there is an abundant food supply for heavy growths of algae, and for this reason it has been necessary to treat the water with copper sulphate many times each summer to keep down the growths.

The second reservoir was built only four years ago and like the first one is an earthen reservoir, but the top soil from this basin was practically entirely removed before it was put into service. This reservoir acts as a preliminary settling basin for the water before it flows to the lower one, the water passing directly from the effluent chamber of this reservoir to the lower one and from there to the ozonization plant.

The raw water feeding these reservoirs is supplied by Herring Run, a small surface water stream subject to some extent to surface pollution of the drainage area, and therefore is usually high in organic matter in suspension and in solution. Algae growths in this stream are as a rule not high but most of the growths develop after the water enters the reservoirs. The raw water receives some aeration just previous to entering the first reservoir, so that the dissolved oxygen is usually about 100 per cent of saturation and the free CO_2 content varies between two and ten parts per million.

In the investigation that was made during the summer of 1914, samples of water were taken regularly as the water flowed into the upper reservoir, again as it flowed into the lower basin, as well as of the effluent from this reservoir and at the pumping station. In all these samples determinations were made of the dissolved oxygen content, free CO_2, bicarbonate and carbonate alkalinity, as well as microscopical examination of the samples, enumerating the organisms present.

Compilation of these analytical data showed that the water during the passage through the upper reservoir increased in temperature 2.5° F., while the dissolved oxygen increased from 90 to 99.5 in percentage of saturation. The free carbon dioxide was reduced in all samples and in some of the samples completely exhausted, and in the samples in which the free CO_2 was all used up the bicarbonates were reduced, on an average, from 52 to 43 parts per million. At the same time it was noted that the average increase in the algae count was from 52 to 260 organisms per cubic centimeter, or an increase of 400 per cent.

In the lower reservoir the average temperature increase over the water in the upper reservoir was 2.5° F.; the dissolved oxygen increased 25.5 in percentage of saturation, while with one exception the free CO_2 was entirely exhausted, and the bicarbonates were reduced 11 parts per million. The algae count in this reservoir increased 8 per cent over the average count in the upper reservoir water, 444.2 per cent increase over the raw water count.

Diagram I shows that as the algae increased there was a proportional increase in the percentage of saturation of dissolved oxygen, although the temperature of the water was greatly increased at the same time.

As is seen in Diagram II, the free CO_2 was exhausted from the water as the micro-organisms increased and the half bound CO_2 from the bicarbonate was drawn upon to furnish the necessary food supply to support the growth. This chart is interesting as it also shows that exhaustion of the free CO_2 that took place during passage through the reservoir was readily replaced after passing through the aspirators of the ozone plant.

Diagram III shows the number of organisms of each species in relation to the total count.

No tests were made in this investigation to compare the bacterial count in the supply with the multiplication of algae, but in tests made in the laboratory it was found that as the algae increased there was a general tendency of reduction in the number of bacteria in the sample (Di ,gram IV); also after the algae had been killed by treating the sample with copper sulphate there was a very great increase in the number of bacteria. To what extent the increase in bacteria was due to an increased food supply caused by killing the algae growth, or the other chemical changes in the supply, is difficult to determine, but it is interesting to note, however, that these forms of vegetation can and do cause great chemical and bacteriological changes in a water in which they thrive.

It is not known if all the microscopical forms of life that are found in waters are capable of bringing about these biochemical changes in a water as have been noted in these tests, but the organisms com-

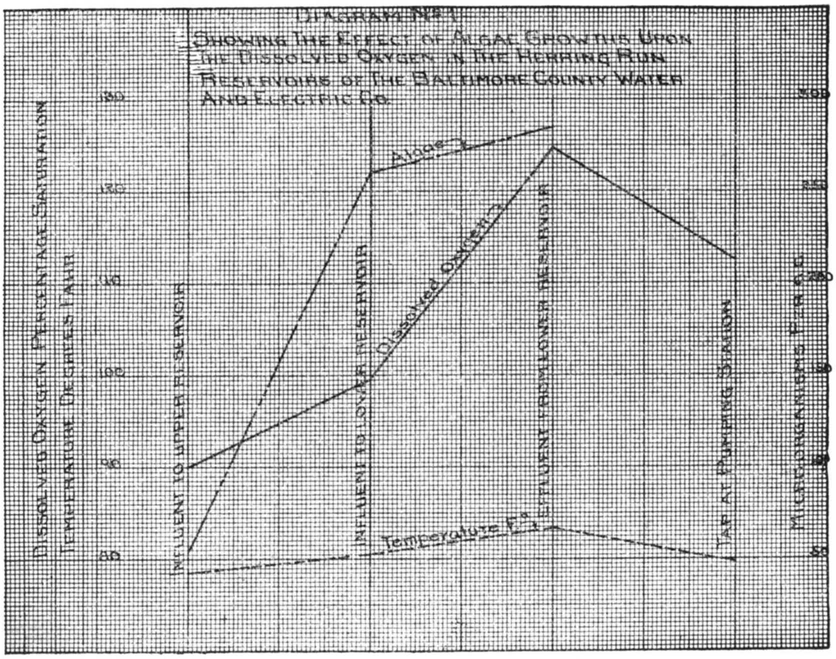
Diagram No. 1
Showing The Effect of Algae Growths Upon The Dissolved Oxygen in The Herring Run Reservoirs of The Baltimore County Water And Electric Co.
Dissolved Oxygen Percentage Saturation
Temperature Degrees Fahr.
130
120
110
100
90
80
Influent to Upper Reservoir
Influent to Lower Reservoir
Effluent from Lower Reservoir
Tap at Pumping Station
Algae
Dissolved Oxygen
Temperature F°
Microorganisms Per c.c.
300
250
200
150
100
50

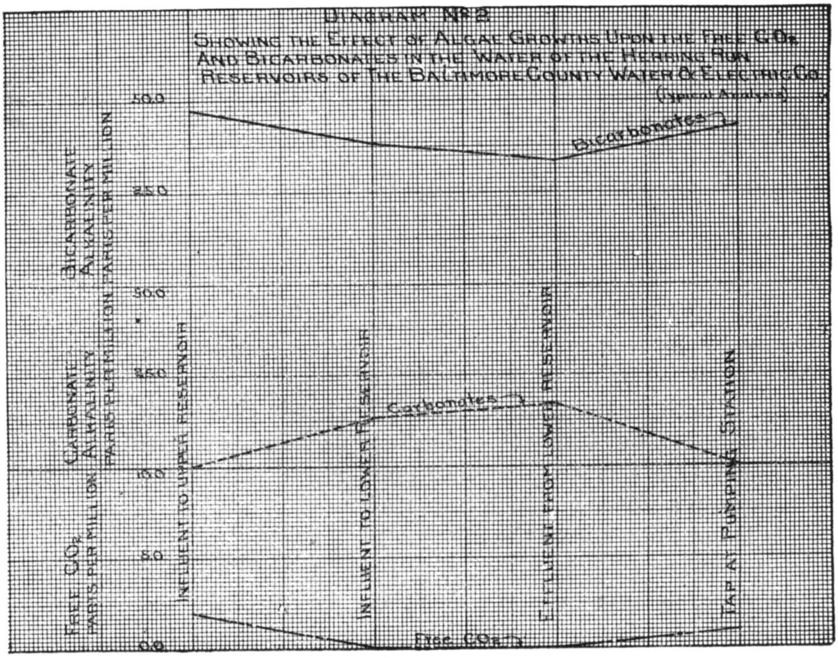
Diagram No. 2
Showing the Effect of Algae Growths Upon the Free CO₂ And Bicarbonates in the Water of the Herring Run Reservoirs of The Baltimore County Water & Electric Co.
(Typical Analysis)
Bicarbonate Alkalinity
Carbonate Alkalinity
Free CO₂ Parts per Million
Parts per Million
Parts per Million
48.0
40.0
32.0
24.0
16.0
8.0
0.0
Influent to Upper Reservoir
Influent to Lower Reservoir
Effluent from Lower Reservoir
Tap at Pumping Station
Bicarbonates
Carbonates
Free CO₂

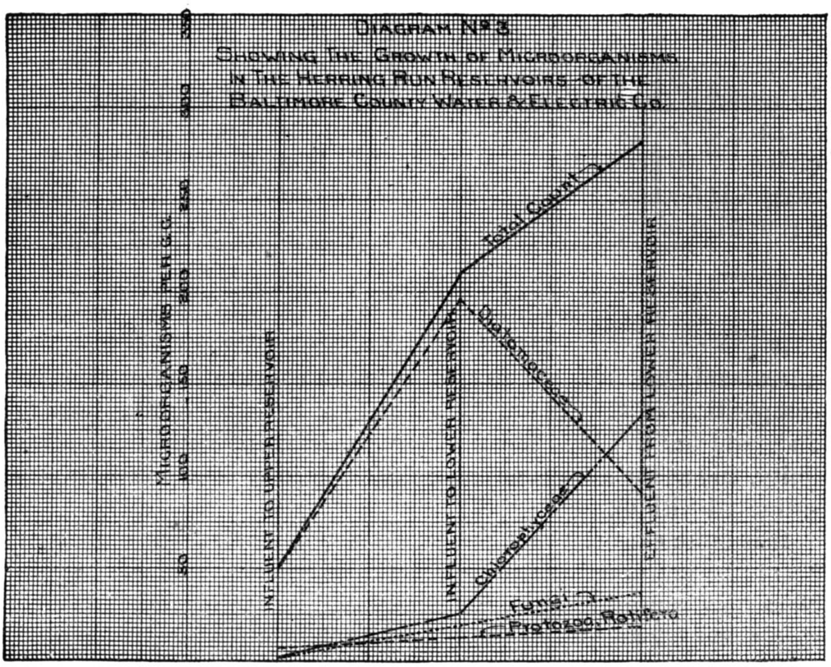
Diagram Nº 3
Showing The Growth of Microorganisms
in The Herring Run Reservoirs of the
Baltimore County Water & Electric Co.
Microorganisms per C.C.
50
100
150
200
250
300
350
Influent to Upper Reservoir
Influent to Lower Reservoir
Effluent from Lower Reservoir
Total Count
Diatomaceae
Chlorophyceae
Fungi
Protozoa, Rotifera

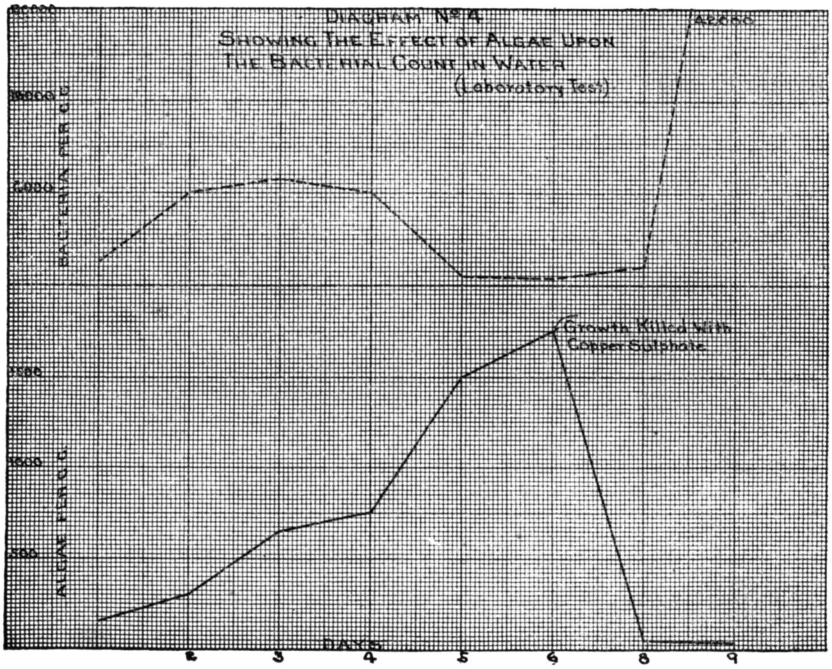
Diagram Nº 4
Showing The Effect of Algae Upon
The Bacterial Count in Water
(Laboratory Test)
Bacteria per C.C.
20000
10000
6000
42000
Growth Killed With
Copper Sulphate.
Algae per C.C.
1500
1000
500
Days
2
3
4
5
6
8
9

prising the true algae are no doubt more active in this respect. During the process of photosynthesis these organisms store up energy by absorbing carbon dioxide from the water and when this is exhausted draw upon the half bound CO_2 in the form of bicarbonates, giving off oxygen at the same time. It is because of this action that oxygen is formed in the water faster than it can be diffused, causing a condition of supersaturation, as has been noted in these tests.

CONCLUSION

It is seen from the above mentioned tests that certain forms of microscopic life in water can cause rapid changes in the chemical composition of the supply by exhausting the free carbon dioxide and reducing the bicarbonate alkalinity to normal carbonate alkalinity, and at the same time cause the water to become greatly supersaturated with oxygen.

It is quite essential that the growth of algae and allied organisms should be prevented in reservoir water, as the neglect of such conditions may cause serious troubles, not only from complaints due to tastes and odors, but on account of filter troubles so often caused by these organisms. Not only are conditions of this kind prevalent but active growths may so alter the chemical composition of the water as to call for radical changes in the methods of operation of the purification systems.